CLAIMS

1. An atomic layer deposition method comprising:

positioning a semiconductor substrate within an atomic layer deposition chamber;

flowing a first precursor gas to the substrate within the chamber effective to form a first monolayer on the substrate;

flowing a second precursor gas different in composition from the first precursor gas to the first monolayer within the chamber under surface microwave plasma conditions within the chamber effective to react with the first monolayer and form a second monolayer on the substrate which is different in composition from the first monolayer, the second monolayer comprising components of the first monolayer and the second precursor; and

successively repeating said first and second precursor flowings effective to form a mass of material on the substrate of the second monolayer composition.

2. The method of claim 1 wherein the first precursor gas comprises $TiCl_4$ and the first monolayer comprises $TiCl_x$.

3. The method of claim 1 wherein the first precursor gas comprises $TiCl_4$, the first monolayer comprises $TiCl_x$, the second precursor gas comprises B_2H_6, and the second monolayer comprises TiB_2.

4. The method of claim 1 wherein the first precursor gas comprises $TiCl_4$, the first monolayer comprises $TiCl_x$, the second precursor gas comprises B_2H_6, the second monolayer comprises, and the mass is formed to consist essentially of TiB_2.

5. The method of claim 1 wherein the first precursor gas comprises $TiCl_4$, the first monolayer comprises $TiCl_x$, the second precursor gas comprises B_2H_6, the second monolayer comprises TiB_2, and the mass is formed to consist of TiB_2.

6. The method of claim 1 wherein the first precursor gas flowing is void of plasma within the chamber.

7. The method of claim 1 wherein the first precursor gas flowing is void of surface microwave plasma within the chamber.

8. The method of claim 1 wherein the first precursor gas flowing comprises plasma within the chamber.

9. The method of claim 1 wherein the first precursor gas flowing comprises surface microwave plasma within the chamber.

10. The method of claim 1 wherein the first monolayer is of a composition which is substantially unreactive with the second precursor under otherwise identical processing conditions but for presence of surface microwave plasma within the chamber.

11. The method of claim 1 wherein the first precursor gas comprises $TaCl_5$ and the first monolayer comprises $TaCl_x$.

12. The method of claim 1 wherein the first precursor gas comprises $TaCl_5$, the first monolayer comprises $TaCl_x$, the second precursor gas comprises NH_3, and the second monolayer comprises TaN.

13. The method of claim 1 wherein the first precursor gas comprises $TaCl_5$, the first monolayer comprises $TaCl_x$, the second precursor gas comprises NH_3, the second monolayer comprises TaN, and the mass is formed to consist essentially of TaN.

14. The method of claim 1 wherein the first precursor gas comprises $TaCl_5$, the first monolayer comprises $TaCl_x$, the second precursor gas comprises NH_3, the second monolayer comprises TaN, and the mass is formed to consist of TaN.

15. The method of claim 1 wherein the component of the first monolayer comprises a metal in elemental form.

16. The method of claim 1 wherein the second monolayer comprises a conductive metal compound, and the mass of material is conductive.

17. The method of claim 1 wherein the second monolayer comprises a dielectric, and the mass of material is insulative.

18. An atomic layer deposition method comprising:

positioning a semiconductor substrate within an atomic layer deposition chamber;

flowing a first precursor gas to the substrate within the chamber effective to form a first monolayer on the substrate;

flowing a second precursor gas different in composition from the first precursor gas to the first monolayer within the chamber under surface microwave plasma conditions within the chamber effective to react with the first monolayer and form a second monolayer on the substrate which is different in composition from the first monolayer, the second monolayer comprising components of the first monolayer and the second precursor; and

after the second precursor gas flowing, flowing a third precursor gas different in composition from the first and second precursor gases to the second monolayer within the chamber effective to react with the second monolayer and form a third monolayer on the substrate which is different in composition from the first and second monolayers.

19. The method of claim 18 successively repeating said first, second and third precursor flowings effective to form a mass of material on the substrate comprising the third monolayer composition.

20. The method of claim 18 successively repeating said first, second and third precursor flowings effective to form a mass of material on the substrate consisting essentially of the third monolayer composition.

21. The method of claim 18 successively repeating said first, second and third precursor flowings effective to form a mass of material on the substrate consisting of the third monolayer composition.

22. The method of claim 18 wherein the first precursor gas comprises $TiCl_4$ and the first monolayer comprises $TiCl_x$.

23. The method of claim 18 wherein the first precursor gas comprises $TiCl_4$, the first monolayer comprises $TiCl_x$, and the second precursor gas comprises H_2.

24. The method of claim 18 wherein the first precursor gas comprises $TiCl_4$, the first monolayer comprises $TiCl_x$, the second precursor gas comprises H_2, the third precursor gas comprises NH_3, and the third monolayer comprises TiN.

25. The method of claim 18 wherein at least one of the first and third precursor gas flowings are void of plasma within the chamber.

26. The method of claim 18 wherein at least one of the first and third precursor gas flowings are void of surface microwave plasma within the chamber.

27. The method of claim 18 wherein both the first and third precursor gas flowings are void of plasma within the chamber.

28. The method of claim 18 wherein at least one of the first and third precursor gas flowings are void of surface microwave plasma within the chamber.

29. The method of claim 18 wherein at least one of the first and third precursor gas comprises plasma within the chamber.

30. The method of claim 18 wherein at least one of the first and third precursor gas flowings comprise surface microwave plasma within the chamber.

31. The method of claim 18 wherein both the first and third precursor gas flowings comprise plasma within the chamber.

32. The method of claim 18 wherein both of the first and third precursor gas flowings comprise surface microwave plasma within the chamber.

33. The method of claim 18 wherein the first monolayer is of a composition which is substantially unreactive with the second precursor under otherwise identical processing conditions but for presence of surface microwave plasma within the chamber.

34. The method of claim 18 wherein the first precursor gas comprises trimethylaluminum and the first monolayer comprises $AlCH_x$.

35. The method of claim 18 wherein the first precursor gas comprises trimethylaluminum, the first monolayer comprises $AlCH_x$, and the second precursor gas comprises H_2.

36. The method of claim 18 wherein the first precursor gas comprises trimethylaluminum, the first monolayer comprises $AlCH_x$, the second precursor gas comprises H_2, the third precursor gas comprise NH_3, and the third monolayer comprises Al_2O_3.

37. The method of claim 18 wherein the first precursor gas comprises $TaCl_5$ and the first monolayer comprises $TaCl_x$.

38. The method of claim 18 wherein the first precursor gas comprises $TaCl_5$, the first monolayer comprises $TaCl_x$, and the second precursor gas comprises H_2.

39. The method of claim 18 wherein the first precursor gas comprises $TaCl_5$, the first monolayer comprises $TaCl_x$, the second precursor gas comprises H_2, the third precursor gas comprises NH_3, and the third monolayer comprises TaN.

40. An atomic layer deposition method comprising:

positioning a semiconductor substrate within an atomic layer deposition chamber;

flowing a first precursor gas to the substrate within the chamber effective to form a first monolayer on the substrate;

flowing a second precursor gas different in composition from the first precursor gas to the first monolayer within the chamber under surface microwave plasma conditions within the chamber effective to react with the first monolayer and form a second monolayer on the substrate which is different in composition from the first monolayer, the second monolayer comprising components of the first monolayer and the second precursor; and

after the second precursor gas flowing, flowing the first precursor gas to the substrate within the chamber effective to react with the second monolayer and both a) remove a component of the second monolayer to form a third composition monolayer on the substrate which is different in composition from the first and second monolayers; and b) form a fourth monolayer of the first monolayer composition on the third composition monolayer.

41. The method of claim 40 wherein the third composition monolayer comprises a metal in elemental form.

42. The method of claim 40 wherein the removed component comprises hydrogen.

43. The method of claim 40 wherein the removed component comprises elemental hydrogen.

44. The method of claim 40 wherein the first precursor gas flowing is void of plasma within the chamber.

45. The method of claim 40 wherein the first precursor gas flowing is void of surface microwave plasma within the chamber.

46. The method of claim 40 wherein the first precursor gas flowing comprises plasma within the chamber.

47. The method of claim 40 wherein the first precursor gas flowing comprises surface microwave plasma within the chamber.

48. The method of claim 40 wherein the first monolayer is of a composition which is substantially unreactive with the second precursor under otherwise identical processing conditions but for presence of surface microwave plasma within the chamber.

49. The method of claim 40 wherein the first precursor gas comprises $TiCl_4$, the first monolayer comprises $TiCl_x$, the second precursor comprises H_2, and the third composition monolayer comprises elemental titanium.

50. The method of claim 40 wherein the first precursor gas comprises $TaCl_5$, the first monolayer comprises $TaCl_x$, the second precursor comprises H_2, and the third composition monolayer comprises elemental tantalum.

51. An atomic layer deposition method, comprising;

positioning a semiconductor substrate within an atomic layer deposition chamber;

flowing a first precursor gas to the substrate within the chamber effective to form a first monolayer on the substrate;

after forming the first monolayer, flowing an inert purge gas to the chamber;

after flowing the inert purge gas, flowing a second precursor gas to the substrate under plasma conditions within the chamber effective to form a second monolayer on the substrate which is different in composition from the first monolayer, the second precursor gas being different in composition from the first precursor gas, said plasma conditions comprising application of energy to the chamber at a power level capable of sustaining plasma conditions within the chamber with the second precursor gas; and

commencing application of said energy to the chamber at an increasing power level up to said plasma capable power level prior to flowing the second precursor gas to the chamber.

52. The method of claim 51 wherein the inert purge gas and second precursor gas flowings do not overlap.

53. The method of claim 51 wherein the inert purge gas and second precursor gas flowings overlap.

54. The method of claim 51 wherein the inert purge gas and second precursor gas flowings overlap, and comprising ceasing the inert purge gas flowing after a ceasing of the second precursor gas flowing.

55. The method of claim 51 comprising after forming the second monolayer, commencing another inert purge gas flowing prior to commencing a reducing of the plasma capable power.

56. The method of claim 55 wherein the second precursor and another inert purge gas flowings do not overlap.

57. The method of claim 51 comprising ceasing flow of the second precursor gas to the chamber prior to commencing a reducing of the plasma capable power.

58. The method of claim 51 comprising:

after forming the second monolayer, commencing another inert purge gas flowing prior to commencing a reducing of the plasma capable power; and

ceasing flow of the second precursor gas to the chamber prior to commencing said reducing of the plasma capable power.

59. The method of claim 51 wherein the plasma conditions comprise surface microwave plasma.

60. The method of claim 51 wherein said increasing is continuous.

61. The method of claim 51 wherein the first precursor gas comprises $TiCl_4$, the first monolayer comprises $TiCl_x$, and the second precursor gas comprises H_2.

62. The method of claim 51 wherein the first monolayer is formed in the absence of plasma within the chamber.

63. The method of claim 51 wherein the second monolayer reacts with the first monolayer, the second monolayer comprising components of the first monolayer and the second precursor.

64. An atomic layer deposition method, comprising;

positioning a semiconductor substrate within an atomic layer deposition chamber;

flowing a first precursor gas to the substrate within the chamber effective to form a first monolayer on the substrate;

after forming the first monolayer, flowing an inert purge gas to the chamber;

after flowing the inert purge gas, flowing a second precursor gas to the substrate under plasma conditions within the chamber effective to form a second monolayer on the substrate which is different in composition from the first monolayer, the second precursor gas being different in composition from the first precursor gas, the second precursor gas flowing under plasma conditions within the chamber commencing before a ceasing of the inert purge gas flowing; and

ceasing the inert purge gas flowing after commencing and while said flowing of the second precursor gas under plasma conditions within the chamber.

65. The method of claim 64 comprising after forming the second monolayer, commencing another inert purge gas flowing prior to a ceasing of the second precursor gas flowing to the chamber.

66. The method of claim 64 wherein the plasma conditions comprise application of energy to the chamber at a power level capable of sustaining plasma conditions within the chamber with the second precursor gas; and commencing application of said energy to the chamber at an increasing power level up to said plasma capable power level commensurate with commencing flow of the second precursor gas to the chamber.

67. The method of claim 64 wherein the plasma conditions comprise application of energy to the chamber at a power level capable of sustaining plasma conditions within the chamber with the second precursor gas; and commencing application of said energy to the chamber at an increasing power level up to said plasma capable power level prior to commencing flow of the second precursor gas to the chamber.

68. The method of claim 64 wherein the plasma conditions comprise application of energy to the chamber at a power level capable of sustaining plasma conditions within the chamber with the second precursor gas; and commencing application of said energy to the chamber at an increasing power level up to said plasma capable power level after commencing flow of the second precursor gas to the chamber.

69. The method of claim 64 wherein the plasma conditions comprise surface microwave plasma.

70. The method of claim 64 wherein the first precursor gas comprises $TiCl_4$, the first monolayer comprises $TiCl_x$, and the second precursor gas comprises H_2.

71. The method of claim 64 wherein the second monolayer reacts with the first monolayer, the second monolayer comprising components of the first monolayer and the second precursor.

72. An atomic layer deposition method, comprising;

positioning a semiconductor substrate within an atomic layer deposition chamber;

flowing a first precursor gas to the substrate within the chamber effective to form a first monolayer on the substrate;

after forming the first monolayer, flowing a second precursor gas to the substrate under plasma conditions within the chamber effective to form a second monolayer on the substrate which is different in composition from the first monolayer, the second precursor gas being different in composition from the first precursor gas, plasma generation of the second precursor gas within the chamber occurring from a second applied power of energy to the chamber, and further comprising applying a steady state first applied power of said energy to the chamber prior to applying said second applied power of said energy, the steady state first applied power being less than the second applied power and increasing the first applied power to said second applied power.

73. The method of claim 72 wherein said increasing is continuous.

74. The method of claim 72 wherein the steady state first power is insufficient to generate plasma from flowing the second precursor gas.

75. The method of claim 72 wherein the steady state first power is insufficient to generate plasma from flowing the first precursor gas.

76. The method of claim 72 comprising applying the steady state first power during the first precursor flowing.

77. The method of claim 76 wherein the steady state first power is insufficient to generate plasma from the flowing first precursor gas.

78. The method of claim 72 comprising flowing an inert purge gas to the chamber intermediate the first and second precursor gas flowings.

79. The method of claim 78 comprising applying the steady state first power during the inert purge gas flowing.

80. The method of claim 78 comprising flowing an inert purge gas to the chamber after the second precursor gas flowing, applying the steady state first power during the inert purge gas flowing intermediate the first and second precursor gas flowings and applying the steady state first power during the inert purge gas flowing after the second precursor flowing.

81. The method of claim 72 wherein the plasma conditions comprise surface microwave plasma.

82. The method of claim 72 comprising commencing the increasing prior to commencing the second precursor gas flowing.

83. The method of claim 72 comprising commencing the increasing after commencing the second precursor gas flowing.

84. The method of claim 72 comprising commencing the increasing commensurate with commencing the second precursor gas flowing.

85. The method of claim 72 comprising reducing power to the steady state first power after a ceasing flow of the second precursor gas.

86. The method of claim 72 comprising reducing power to the steady state first power prior to a ceasing flow of the second precursor gas.

87. The method of claim 72 wherein the first precursor gas comprises $TiCl_4$, the first monolayer comprises $TiCl_x$, and the second precursor gas comprises H_2.

88. An atomic layer deposition method, comprising;

positioning a semiconductor substrate within an atomic layer deposition chamber;

applying a base power level of energy to the chamber with the substrate positioned therein;

while applying the base power level of energy, flowing a first precursor gas to the substrate within the chamber effective to form a first monolayer on the substrate under non-plasma conditions within the chamber;

after forming the first monolayer, raising the base power level of said energy to a power level capable of generating plasma within the chamber;

flowing a second precursor gas to the substrate within the chamber while said plasma capable power level of said energy is applied to the chamber effective to form a plasma with said second precursor gas against the first monolayer to form a second monolayer on the substrate which is different in composition from the first monolayer; and

after forming the second monolayer, reducing the plasma capable power level of said energy to the base power level and thereafter depositing another monolayer onto the second monolayer.

89. The method of claim 88 wherein said raising is continuous.

90. The method of claim 88 comprising flowing an inert purge gas to the chamber intermediate the first and second precursor gas flowings.

91. The method of claim 90 comprising applying the base power level of energy during the inert purge gas flowing.

92. The method of claim 90 comprising flowing an inert purge gas to the chamber after the second precursor gas flowing, applying the base power level of energy during the inert purge gas flowing intermediate the first and second precursor gas flowings and applying the base power level of energy during the inert purge gas flowing after the second precursor flowing.

93. The method of claim 88 wherein the plasma comprises surface microwave plasma.

94. The method of claim 88 comprising commencing the raising prior to commencing the second precursor gas flowing.

95. The method of claim 88 comprising commencing the raising after commencing the second precursor gas flowing.

96. The method of claim 88 comprising commencing the raising commensurate with commencing the second precursor gas flowing.

97. The method of claim 88 comprising commencing said reducing after a ceasing flow of the second precursor gas.

98. The method of claim 88 comprising commencing said reducing prior to a ceasing flow of the second precursor gas.

99. The method of claim 88 wherein the first precursor gas comprises $TiCl_4$, the first monolayer comprises $TiCl_x$, and the second precursor gas comprises H_2.